COILING INTO A SPHERE: DEFENSIVE BEHAVIOR OF A TRASH-CARRYING CHRYSOPID LARVA *LEUCOCHRYSA (NODITA) PAVIDA* (NEUROPTERA: CHRYSOPIDAE)[1]

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ABSTRACT: The trash packet that many chrysopid larvae carry on their backs is a defensive device. The larvae use the packet as a shield, which they interpose between themselves and attacking ants by tilting the body in the appropriate direction. *Leucochrysa* (*Nodita*) *pavida* is anomalous in that it uses its packet as a wraparound by coiling into a sphere when attacked. The response, which leaves the larva entirely concealed by the packet, is effectively protective. Coiling protects other arthropods against ants as well.

Many chrysopid larvae have the habit of carrying a packet of exogenous material on their back (Smith 1922, Canard et al. 1984). They use a variety of matter for the purpose, including vegetable debris, arthropod remains, and insect waxes (Smith 1922, Slocum and Lawrey 1976, New 1969, Eisner et al. 1978, Canard et al. 1984, Mason et al. 1991). Typically, they scoop up the material by use of their jaws and deliver it on the back by flexion of the front end (Smith 1922, Principi 1940, New 1969). Special bristles that project outward from the sides of the body, and others with recurved tips that project upward from the back, serve for retention of the packet (Canard et al. 1984). Larvae that construct such packets are appropriately known as trash carriers.

Existing evidence indicates that the packets act as protective shields. Ants, for example, were shown to desist from pressing their assault upon trash-carrying larvae if upon attempting to bite these they seized only parts of the packet (Principi 1946, Eisner et al. 1978, 2002). Also, reduviid bugs were noted to reject trash-carriers if they failed to reach the body of the larvae when probing through the packets with their beaks (Eisner et al. 2002). Packets proved deterrent to geocorid bugs as well (New 1969).

Over the years we have had the opportunity to make casual observations on a number of trash-carrying chrysopid larvae that we encountered at various locations in Florida. These included larvae of three species of *Ceraeochrysa* [*C. cubana* (Hagen), *C. cincta* (Schneider), *C. smithi* (Navás)] and two of *Leucochrysa* [*L. (Nodita) floridana* (Banks) and *L. (Nodita) pavida* (Hagen)]. We had occasion to subject some of these larvae to attack, by releasing them individually into Petri dishes together with one or more ants. Encounters were quick to follow. When ants attacked singly, the larvae usually succeeded in fending them off. The moment they were contacted by an ant they tilted the body in such fashion as to cause the packet to become interposed between

[1] Received March 15, 2001. Accepted August 23, 2001.

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themselves and the ant. The ant then often backed away, but even when it pursued the attack, it was usually foiled by being able to bite into the packet only. The larvae proved able to maneuver the shield in virtually every direction. No matter from where the ant attacked, they seemed always to deploy the shield in the appropriate angle.

The larvae were not as successful when attacked simultaneously by more than one ant. Under such circumstances ants could sometimes "break through" from one direction while the packet was tilted in another. Such breakthroughs, we found, could be fatal to a larva, since ants tended not to relinquish their hold once they had succeeded in biting into the body of the larva, and the bites often resulted in profuse hemolymph loss.

One particular larva fared differently from the others in that it proved able to withstand the assault of groups of ants. That larva – *Leucochrysa pavida* (Figs. 1, 2) – which typically constructs its packet from tiny pieces of lichens (Slocum and Lawrey 1976), resorted to a behavior that we observed with none of the other species and which seemed intended to provide for the shielding of the body as a whole. *L. pavida*, we found, rolls into a sphere when persistently assaulted, essentially wrapping itself in the packet. We saw the larvae "coil up" when attacked by groups of ants [*Camponotus floridanus* (Buckley)] in our test dishes and they were able to withstand such assaults without sustaining injury. Coiling also caused the larvae to lose their foothold, which under natural circumstances, should the assault occur at some height above the soil, would most likely result in them falling to the ground. The cost incurred by such physical displacement should be bearable, given the benefits gained by the escape.

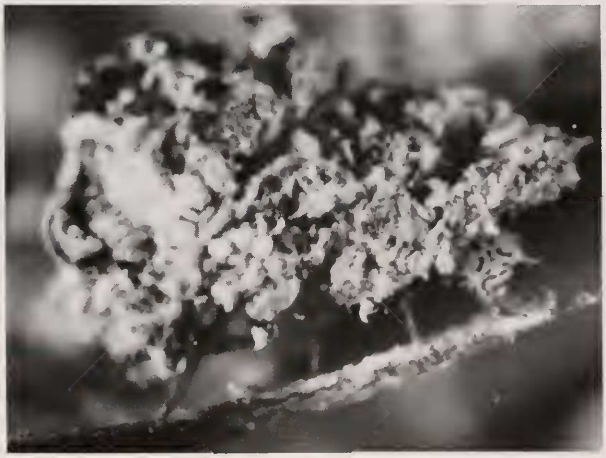

Figure 1. *Leucochrysa pavida* larva. Reference bar = 1 mm.

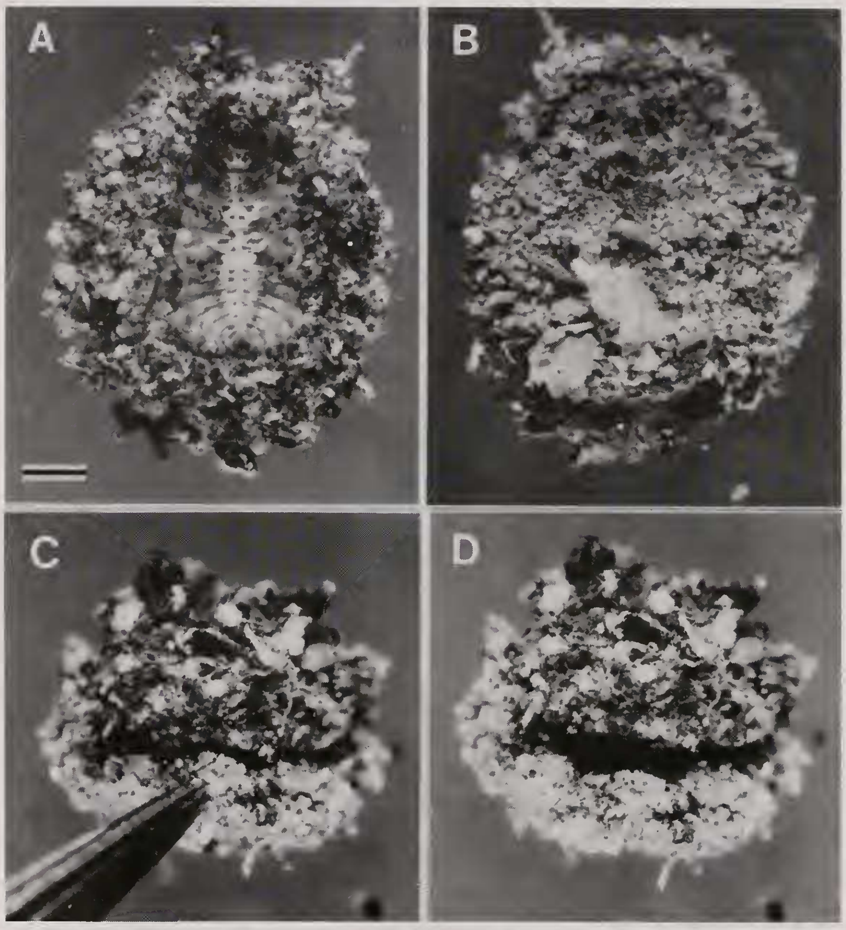

Figure 2. *Leucochrysa pavida* larva. (A) Ventral view, normal ambulatory posture (larva photographed through glass plate). (B) Same, dorsal view. (C) Coiled, in response to poking with forceps. (D) Same, beginning to uncoil after disturbance has subsided. Bar: A = 1 mm.

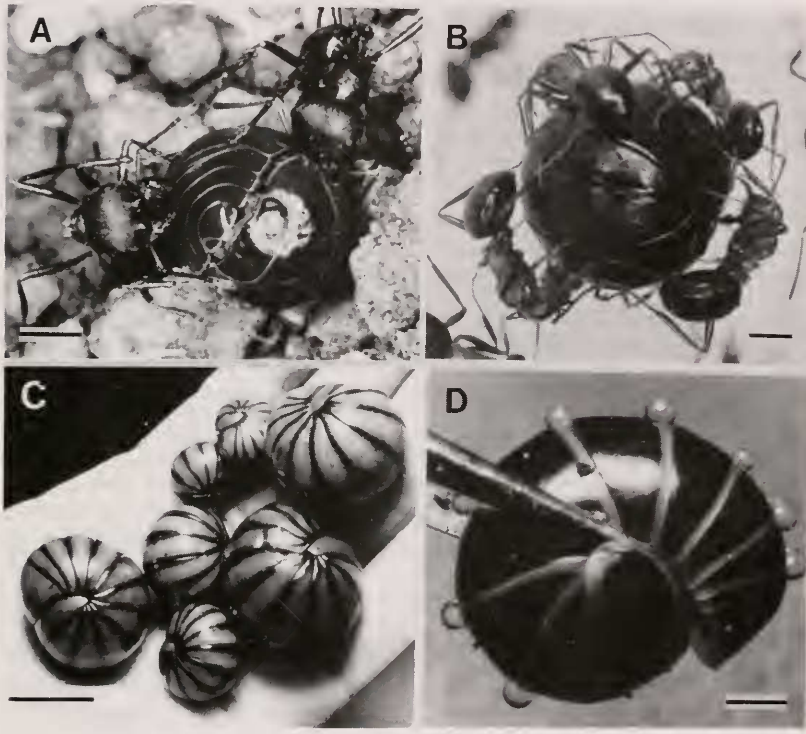

Figure 3. Coiling arthropods. (A) *Armadillidium* sp., under attack by *Pogonomyrmex occidentalis* (Cresson); attack staged in the laboratory at the Southwestern Research Station of the American Museum of Natural History, Portal, Arizona. (B) Cockroach (*Perisphaerus semilunatus*) under attack by *Formica exsectoides* (Forel); encounter staged in the laboratory at Ithaca, New York. (C) Oniscomorph millipedes from South Africa, coiled in response to handling. (D) Glomerid millipede (*Glomeris marginata*) coiled in response to being seized in forceps; this millipede, which is also chemically protected, is here seen emitting droplets of defensive secretion from its mid-dorsal glandular pores. Bars: A, B = 2 mm, C = 2 cm, and D = 1 mm.

Coiling behavior has evolved independently in a number of arthropods. Over the years we have carried out predation tests with some of these, always with ants, which we found frequently to be thwarted by prey "that turned into a sphere". Thus, we found coiling behavior to be effectively defensive in sow bugs (isopod Crustacea) (Fig. 3A), in a cockroach from Thailand, *Perisphaerus semilunatus* (Hanitsch) (Fig. 3B), in oniscomorph millipedes (Eisner and Davis 1967) (Fig. 3C), and in the millipede *Glomeris marginata* (Villers) (Meinwald et al, 1966) (Fig. 3D). A comparative study of the effectiveness of coiling behavior, based on quantitative assays and looking into the full range of species that make use of it, could prove worthwhile.

ACKNOWLEDGMENTS

We are indebted to Kady and Maurice Tauber for identifying the chrysopids, to Louis M. Roth, for providing the live *Sphaerotheria*, and to the late William L. Brown Jr. for identifying the ants. We located the *L. pavida* larvae on the grounds of the Archbold Biological Station, Lake Placid, Highlands Co., FL. The study was supported in part by grant AI02908 from the National Institutes of Health and by the Cornell University Agricultural Research Station federal formula funds, Project No. NYC-191424 received from Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture. Any opinions, findings, conclusions or other recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture. E. Richard Hoebeke commented on the manuscript. This is paper no. 180 in the series "Defense Mechanisms of Arthropods; paper no. 179 is Iyengar et al, "Parental Body Mass as a Determinant of Egg Size and Egg Output in an Arctiid Moth (*Utetheisa ornatrix*)". J. Insect Behav. (submitted).

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